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DIET AND HEALTH IN RURAL HAWAII

MARTHA POTGIETER
KIYO NAKATANI

HAWAII AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF HAWAII

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HAWAII AGR. EXPT. STA. TECH. BUL. 21

On page 22, under column headed Calories, read
Hawaiian 22, Oahu Japanese 16.

NOTE: Martha Potgieter is at present Associate Professor of Foods and Nutrition at the University of Connecticut. The present address of Kiyo Nakatani is Captain Cook, Kona, Hawaii.

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FOREWORD

The project covered by the report in this bulletin was initiated in 1938 by Dr. Martha Potgieter, and the field work and a first draft of the manuscript were completed by the summer of 1941.

Dr. Potgieter planned the details and carried on the work on the Island of Oahu, and under her direction Mrs. Kiyo Nakatani did the field work in Kona. Dr. Potgieter also made the arrangements for the dental and physical examinations and assisted the examining dentist and physician, in both Oahu and Kona. Dr. Potgieter was granted sabbatical leave for the academic year 1941–42 with the expectation that she would complete the manuscript for publication when she returned in 1942.

December 7, 1941, not only changed the course of history; it interfered with research work all over the world. All Hawaii Agricultural Experiment Station personnel on leave were advised to take positions elsewhere. Dr. Potgieter accepted a position on the Mainland. It was hoped that after the war she might return to Hawaii temporarily to complete this work, but that never proved possible.

Because no other similar study had previously been undertaken in Hawaii, and none has been done since, it is believed that the results of this survey are a valuable contribution to our knowledge of dietary practices in Hawaii at that date. Moreover, food habits change slowly, and it seems unlikely that they are markedly different among similar groups of rural families today.

The results of this study show clearly the need for continuing to emphasize improved food habits and the part good nutrition can play in promoting physical and dental health.

Dr. Hazel Murray, Nutritionist 1951–53, rechecked calculations for portions of the dietary studies and prepared some new tables. Mrs. Nakatani made the calculations and summaries for the Kona families. I rewrote certain sections of the report, especially that on dental conditions, and edited the entire manuscript.

In case of differences of opinion in presentation of material or interpretation of data, the ideas of the senior author had precedence.

CAREY D. MILLER
Head, Foods and Nutrition Department

August, 1952.

ABSTRACT

Between 1938 and 1941, 140 families living in the rural area of the Island of Oahu and in the Kona district of the Island of Hawaii co-operated with the Hawaii Agricultural Experiment Station in making a study of their family food habits and the health of their children. Of the 117 families who completed the study, 64 were of Japanese ancestry (39 on Oahu and 25 in Kona), 48 were part-Hawaiian (referred to as Hawaiian) living in rural Oahu, and 5 were of Chinese ancestry living in rural Oahu.

Home food inventories preceded and followed the 28-day record of foods brought into the home and consumed by each family. The number, sex, and ages of the people consuming the foods (including guests), and the number of meals eaten away from home were recorded.

Physical and dental examinations of the children in these families were made by one pediatrician and one dentist.

Some of the more important findings are here summarized:

1. Distribution of total calories among the various food groups indicates too high a percentage of calories from highly milled cereals (white rice and bread), insufficient calories from fruits and vegetables, inadequate consumption of milk, and adequate or excessive consumption of meat, fish, and eggs.
2. Average per capita daily intakes of dietary essentials indicate an adequate calorie consumption, on the whole, by all groups except the Chinese; an adequate intake of protein by all but a few families; a seriously inadequate calcium intake by practically all the families; a thiamine intake about 50 percent below the current standard for the Japanese families and somewhat less deficient for the Chinese and Hawaiian families; an adequate, or nearly adequate, vitamin A intake by most of the families; and an adequate intake by all families of iron, phosphorus, and vitamin C.

   A more detailed analysis of food consumption and intake of dietary essentials showed that the families varied greatly and only a few met, or almost met, the recommended standards for all nutrients.
3. There was a positive correlation between the amount of money spent for food and the degree of adequacy of the diets. About one third of the families were spending too little money for food in order to obtain an adequate diet. An adequate family food budget did not insure an adequate family diet.
4. Sixty-seven percent of the Hawaiian children and 57 percent of the Japanese children were classified as being in a good nutritional state. Not one was found to be in a definitely poor nutritional state. In the Hawaiian children there was a closer relationship between nutritional status, as determined by the physical examination, and deviation from Baldwin-Wood weight standards than with deviation from the Pryor standards. In the Japanese children the correlation was closer between nutritional status and deviation from the Pryor standards. The children of Hawaiian ancestry were 4 percent taller and 13 percent heavier than the children of Japanese ancestry. The Japanese children in this study were 10 percent heavier than Japanese children in Hawaii 20 years ago.
5. Ninety-eight percent of the Hawaiian and 100 percent of the Japanese and Chinese children over 5 years of age were found to have dental decay.

The mean D.M.F. rates (decayed, missing, and filled teeth per person) for all the children from 6 to 20 years of age, inclusive, for each of the four groups, were as follows: (a) Oahu Hawaiians, 8.35; (b) Oahu Japanese, 10.33; (c) Kona Japanese, 10.48; and (d) Oahu Chinese, 10.84. There were many abscessed deciduous teeth in the 6- to 8-year age group, varying from a mean per child of 1.29 for the Hawaiians to 4.60 for the Chinese children. The condition of the first permanent molars in all groups was comparatively poor but better in the Hawaiians than in the other groups.

6. Children with good diets tended to have better nutritional ratings than those with poorer diets. They also had better skeletal development and better teeth and were more nearly normal in weight. This relationship between adequacy of the diet and nutritional status was more marked in the 1- to 6-year age group than in the older ones.

A number of recommendations, based on the findings in this study, are summarized as follows: (a) Family diets should be improved through better food selection and by more home gardens; (b) there should be closer supervision of children's meals and between-meal snacks to aid in the formation of good food habits; (c) the importance of an adequate diet for good dental health should be stressed; (d) teaching which emphasizes the relationship between diet and health must be continued for all age groups and for both sexes.

CONTENTS

INTRODUCTION

There is no longer any doubt that what man eats has a very direct and profound, though not always immediate, effect on his physical well-being. Recognition of the fact that malnutrition is one of the greatest plagues of civilized man led to the Health Organization of the League of Nations and after World War II to the formation of the Food and Agricultural Organization of the United Nations with one of its chief aims being "to improve nutrition of the people of all countries."

Between the serious dietary deficiency diseases, such as beriberi, scurvy, rickets, pellagra, and xerophthalmia, and the ideal nutritional state, there is a wide zone of border line deficiencies where the individual has lowered resistance to fatigue and disease. Of course, many other factors can affect the apparent nutritional status, such as occupation, climate, lack of exercise, housing, sanitation, infections, parasites, inherited physique, poor digestion, and psychological environment. But in large population groups, those that are well-fed are superior physically to those that are poorly fed, and they are subject to fewer illnesses.

The great progress that has taken place in the feeding of farm animals during the past 50 years is the outgrowth of experiments conducted on the same species of animals, as well as on small laboratory animals like the white rat, and of the expanding knowledge of biological and food chemistry.

The difficulties encountered in experimenting upon man, with his long life span, are obvious. Only experiments of short duration are feasible because of the time and expense involved. The range of foodstuffs consumed by various population groups and the possibility of maintaining good health on markedly different diets complicate the problem still further. About the best that we can do is to observe what people eat and learn something of their health at the time the diet is studied, though we are quite aware that what has been eaten during the previous 10 or 20 years is equally, or perhaps more, important.

Enough is now known about nutritional requirements to enable us to evaluate the nutritive quality of diets and to make recommendations for some improvements. From observations of people in various parts of the world and studies of their food and their health, recommended daily allowances (often called standards) have been made for calories and for at least eight of the important nutrients, for people of various ages and both sexes (*19*). Such recommended standards are placed sufficiently high to allow for individual differences and variations in the nutritive values of foods. These recommended daily allowances serve a useful purpose in permitting an evaluation of the quality

of diets in various parts of the world, and they have been so used in this study.

At the time this study was planned and the original data collected, the Bureau of Home Economics (now the Bureau of Human Nutrition and Home Economics) of the United States Department of Agriculture was making and had begun publication of a series of studies of family incomes and expenditures in five regions in the mainland United States for farm, village, and city families. Family food consumption and the nutritive value of foods eaten were an important feature of these inquiries (*3, 12, 28, 29, 30*). Hawaii was not included in any of these studies. In addition, some of the experiment stations (e.g., Vermont, South Carolina, Iowa, and Ohio, to mention only a few) had made family dietary studies, but none of these included observations on the health and dental status of the school children (*13, 17, 18, 20*).

OTHER STUDIES IN HAWAII

In 1938, when this work was initiated, only a few studies on cost of living and food consumption had been made in Hawaii, none of which included observations of the health of family members.

Among the earliest published studies in the Islands which contain some information on cost of living and family food expenditures are the Reports of the Commissioner of Labor on Hawaii (*34, 35*). The third report, in 1906 (*36*), gives somewhat more detail than the two previous reports and points out that the cost of living varies for Honolulu and the country regions and for different classes of workers. An American-born carpenter reported that "my family expenses are about $75 a month, without counting clothing and extras," for a family of five children and himself, his wife being dead. His grocery bill was $28 to $30 a month, and in addition he paid $12 to $14 for fresh meat ("most meats were around 20 cents a pound"), $3.50 for fresh milk, and fresh vegetables were purchased at the door from Chinese market gardeners. The monthly rent for their cottage was $20. Monthly earnings were, of course, in proportion. Another American carpenter who had moved to Hawaii from the Middle West said, "I own a lot and have built my own house, I raise my own chickens and have plenty of eggs; and also have my own fruit, including several varieties of bananas, papayas, guavas, and mangoes; and raise such vegetables as turnips, beets, carrots, and lettuce. If I kept a cow I should hardly have to work to supply my table."

Not until 1943, during World War II, did the Department of Labor carry out a rather complete study in Honolulu (*5*) which in 1944 was extended to three of the other Islands (*32*). These studies provide a good over-all picture of family incomes and expenditures, including the amounts and percentages spent for different classes of foods and for some individual foods, but give no data on quantities of various foods used. These two Department of Labor studies were done after the Foods and Nutrition Department of the Hawaii Agricultural Experiment Station had collected the data on food consumption of the farm families here reported.

In 1934 Mrs. Edna Clark Wentworth made a study of the incomes and expenditures of more than 100 plantation Filipino families (*37*), and an evaluation of the nutritive value of the diet of 20 of these families was later included in a bulletin on Filipino foods used in Hawaii (*15*) published by this Station.

In 1937–38, members of the Economics Department of the University made

a study of the incomes and disbursements of 218 middle-income families in Honolulu (*9*) which included expenditures for various foods and classes of foods but no information on quantities used per person or per family.

Assisted by students who had collected the original data, Miller (*14*) in 1938 published the results of a study of the dietary and value of living of 44 Japanese families in Hawaii which included detailed figures on the amounts and costs of different classes of foods, and the adequacy of the diets.

A study of the adequacy of diets of 38 Honolulu families on relief, by Potgieter (*21*), was published in 1944, but the study was made prior to the war. In addition to the dietary study, this report includes a summary of the dental status of 90 of the children in the 38 families.

PURPOSE AND PLAN OF THE STUDY

The purpose of this study was three-fold:

(1) To study the food consumption of several racial groups among the rural population in the Territory and to determine the nutritional adequacy of the diets by comparison with standard daily allowances for calories, protein, three essential minerals (calcium, phosphorus, and iron), and three well-known and important vitamins (A, B_1, and C).

(2) To secure useful information regarding food habits of some rural Island families which should be of value and of interest to all concerned with nutrition, health, and welfare throughout the Territory.

(3) To determine the nutritional status of the children in these families and to look for any possible effects of dietary deficiencies on their health, growth, and dental status.

The plan of this study covers five phases:

(1) Families were asked to keep records of their total food consumption for a period of 4 consecutive weeks; complete inventories of food in the home were made at the beginning and at the end of the month.

(2) All the school children and preschool children in these families were examined and measured by one pediatrician, and dental examinations were made by one dentist.

(3) The data on food consumption were tabulated, summarized, and evaluated.

(4) The adequacy of the family diets in eight dietary essentials (calories, protein, calcium, phosphorus, iron, and vitamins A, B_1, C) and the relationships between family diet and child health were studied.

(5) After the food study, the co-operating families were given suggestions on food selection and the nutritive values of foods (in conference and in simple, mimeographed pamphlets prepared by this Department and based on the findings in their food records), with a view to helping them obtain more adequate family diets.

METHODS

Selection of Families. Families in rural Oahu were contacted through University Extension clubs for women and Parent Teachers Associations, or through interested and influential individuals in rural communities. Six areas in rural Oahu and the Kona district on the Island of Hawaii were studied. (The study of family diets of coffee growers in the Kona district was made by

Table 1

Racial and Geographic Distribution of the Co-operating Families

	OAHU	KONA	TOTAL
Hawaiian	48	....	48
Japanese	39	25	64
Chinese	5	....	5
	92	25	117

Kiyo Nakatani, under the direction of the senior author.)

One hundred and forty rural families co-operated in this study. Twenty-two families are omitted from this report because of incompleteness of the food records. The record of a single Caucasian family is also omitted. Table 1 shows the racial and geographic distribution of the 117 families who completed the 4-week food study.

In the Japanese and Chinese families both parents were of Oriental ancestry. Although the term Hawaiian, rather than part-Hawaiian, will be used for convenience in referring to any families in which there was Hawaiian blood in either parent, it should be clearly understood that in no families were there full-blooded Hawaiians. Other racial stocks of the part-Hawaiian group were principally Caucasian, but there were also Chinese and several Japanese.

Although only five Chinese families co-operated in the study, they have been included because their dietaries seemed typical of this racial group, judging from experience with diets of students of Chinese ancestry.

Racially, the group was approximately representative of the nonplantation rural population of the Territory. Census data for 1940 (*33*) show the following racial distribution for the whole Territory:

All races	423,330	Filipino	52,569
Hawaiian	14,375	Japanese	157,905
Part-Hawaiian	49,935	Korean	6,851
Caucasian	103,791	Negro	255
Chinese	28,774	Puerto Rican	8,296
		All others	579

A majority of the Japanese families were independent farmers—vegetable growers and a few pig growers. A few were shop keepers or civilian employees at nearby army posts. The Kona families were all coffee farmers except one. Nine of them raised only coffee; the remainder combined coffee with other types of farming and/or with full or part-time employment. A majority of the Hawaiian families were employed at nearby army posts or sugar plantations or on road construction projects; a few were vegetable or pig growers. The farms ranged in size from 1 to 14 acres. The farming carried out was of the intensive type.

Families with children were selected, in preference to those without children. The average number of children per family is shown in table 2.

There are no accurate figures for average family size in Hawaii, as the 1940 census reports only size of household which includes lodgers, servants, and other unrelated persons, as well as students away from home at school or college and other members temporarily absent. For the total population the average number of persons per occupied unit was 4.87 according to the 1940 census (*33*).

Collection of Food Consumption Data. On the first day of the diet study, an inventory was made of all food in the home. Then the co-operating member of the family (usually the mother, but in some cases a grown daughter or son, and in one case the father) was asked to record each day, for 4 consecutive weeks, all foods brought into the home for family use—their source, kind, amount, and cost. Most of the families did not have household scales, so the weight as given by the merchant or vendor was recorded. Home-grown food items used were carefully described as to number and size.

Meals and lunches eaten away from home by family members were recorded, also guests in the home for meals or between-meal lunches. Food fed to pets (other than table scraps), foods recorded for family use and then given away as gifts, and foods discarded because of spoilage were recorded.

Each family was visited from one to three times a week during the study. Family records were collected and checked with the mother for correctness and completeness, and the blank forms needed were left at the time of each visit. These family visits on Oahu were made by the senior author, by an assistant trained in home economics, or by one of three field agents—rural women who had just completed their own food records and had received special instructions for helping with the study of other families in their communities. In Kona these visits were made by the junior author, who made the study in that area.

The 4-week period for the diet study in each community was so selected as to be free from any holidays or events which would appreciably affect family food habits. The group studies were scattered throughout the year, most of them falling within the school year (September to June). Seasonal variations in available foods and food customs are very slight in Hawaii in comparison with mainland United States, because of the almost continuous supply of local fresh vegetables and fruits.

All families were urged to follow their usual food habits during the 4-week period of the study, so that the food usages recorded would be truly

Table 2

Average Size of Families

	NUMBER OF CHILDREN PER FAMILY		AGE RANGE OF CHILDREN	SIZE OF FAMILIES	
	Average	Range		Average	Range
			years		
Hawaiian	5.4	1 to 12	under 1 to 18	7.1	3 to 12
Oahu Japanese	4.0	1 to 11	under 1 to 27	6.9	3 to 15
Kona Japanese	4.5	1 to 8	under 1 to 24	7.6	3 to 13
Chinese	5.6	2 to 9	2 to 21	8.2	5 to 11

representative of the customary family diet. Answers to all questions by the mothers regarding the nutritive value of various foods were deferred until the study was completed.

At the end of the 4-week period an inventory of food in the home was again made. A few of the family food records were made for only 25, 26, or 27 days, and a few were for 29, 30, or 31 days. However, more than three fourths of the food records were for exactly 28 days, and the others were calculated to a 28-day basis.

Physical Examination of the Children. Following the food study, 553 children and youths (including a few beyond high school age) in the 117 co-operating rural families were examined by one pediatrician and one dentist. The Foods and Nutrition Department was fortunate in securing for these examinations the services and excellent co-operation of a pediatrician, who was also trained in Public Health and in anthropometry, and a dentist specializing in children's dentistry and formerly engaged in dental research. Through the co-operation of the 16 public schools in the communities in which the families lived, the school children were examined during the school day and the preschool children and babies after school hours, in the first-aid or health room of the school.

Mothers were urged to be present, and usually were, at the examination of the small children. At this time the mothers were advised by the doctor and the dentist as to the care of their children in matters of health, dentition, and diet. For the physical examination the smaller children were entirely undressed and older children usually removed all clothing except one garment.

Records were made of height, sitting height, hip width, and body weight. In addition, the physical examination of each child included the following observations: eyes, ears, nose, throat, mouth, and tonsils for evidence of infections; heart and lungs (with stethoscope); spleen and glands (by palpation); skin; skeletal development (chest, legs, wrist, forehead); type of body build; firmness of arm and leg muscles; posture (shoulders, scapulae, back); and secondary sexual development. Each child was rated as to general nutritional status on the basis of the above findings and his general appearance.

Dental Examination of the Children. Five hundred and forty-five subjects, from 2 to 20 years of age, inclusive, and eight young adults over 20 were examined by the one dentist. All examinations were made with mirror and new sharp explorers, under favorable lighting conditions, without drying the teeth. All surfaces of all teeth were examined, and missing teeth and general mouth conditions were observed. The children's dental record cards, printed by the Bureau of Public Relations, American Dental Association, were used for recording the following data: (1) number of cavities (each decayed area was recorded as one cavity, regardless of size and depth; pits and fissures in which the explorer caught were carefully inspected and, if definitely carious, were recorded as cavities), (2) number of teeth with cavities (deciduous and permanent), (3) number of fillings, (4) number of teeth with fillings (deciduous and permanent), (5) number of missing teeth (those that were not in the mouth but should have been there), (6) abscesses, (7) gingivitis, (8) oral hygiene, (9) occlusion, and (10) supernumerary teeth. The total number of decayed (D), missing (M), and filled (F) teeth were recorded for each

child and were designated as the total number of defective teeth. The D.M.F. rate is considered a satisfactory method of evaluating the dental status of large groups, as it is both objective and rapid (*24*). All missing teeth (permanent teeth that had been lost and temporary teeth extracted much too early) were considered to have been extracted because of decay. Any loss of teeth through accident or other injury would have been learned through questioning the child (or its mother, in cases of small children). An occasional supernumerary tooth was not included in the total count of defective teeth.

FINDINGS

Food Consumption Habits. Each family's total consumption of all foods during the 28-day period was calculated from the two inventories and the daily records of food brought into the home during the study. Those family diet records which were a little less or more than 28 days in length were calculated to a 28-day consumption basis.

No deduction was made from the total foods used to allow for waste in the home (aside from the inedible portion of the foods). (In some studies of family food consumption 5 or 10 percent is deducted for food waste.) From observation it was noted that in the more thrifty families there was probably very little waste; in others there may have been considerable. The amount of food waste in a home is influenced by refrigeration facilities, the mother's knowledge of careful buying, the care and preparation of foods, and children's habits in the use of food.

Yearly Per Capita Consumption of Selected Foods and Food Groups. The average yearly per capita consumption of various foods, by the four groups of families, is given in table 3. The Bureau of Home Economics' recommended consumption of the various foods (at two diet cost levels) is also given for comparison (*27*).

Since members of each family ate some meals away from home, calculations to obtain the complete dietary intake for all families were made as follows: the total number of meals for each family was calculated by multiplying the total number of meals for the 28-day period (84) by the number in the family. From this total the number of meals eaten out by members of the family was subtracted, and the number of meals eaten by guests added. The number of individuals per family was obtained by dividing number of meals served in the home by 84. Factors for each group were then used to calculate the per capita food intake for a year which is shown in table 3.

The consumption of milk by families of each of the four groups studied was only one fourth to less than one fifth of that recommended by the Bureau of Home Economics for a minimum cost diet.

The consumption of leafy, green, and yellow vegetables by the Kona Japanese and by the Chinese compares favorably with the Bureau's recommendation for the minimum cost diet. The per capita consumption of fruits high in vitamin C by all groups met or exceeded the recommended amount for the minimum cost diet, but all are lower than the moderate cost diet.

The per capita consumption of cereals by the Chinese is somewhat greater, and that of the Japanese about 50 percent greater, than the Bureau's recommendation for the minimum cost diet.

Table 3

Average Yearly Per Capita Consumption (by Pounds) of Selected Foods and Food Groups, Compared with the Recommendations of the Bureau of Home Economics for Two Expenditure Levels (27)

FOOD ITEM	FAMILIES IN HAWAII				BUREAU OF HOME ECONOMICS RECOMMENDATIONS (27)	
	Hawaiian	Oahu Japanese	Kona Japanese	Chinese	Minimum cost diet	Moderate cost diet
Cereals: (total)	200	369	348	243	224	160
Refined (total)	183	362	341	234		
Whole-grain (total)	17	7	7	9		
Rice: polished	73	266	266	166		
brown	0	0	0.14	0		
Milk (fresh milk equivalent) (total)*	139	108	94	92	520	610
Fresh whole	45	48	58	52		
Evaporated	47	30	18	20		
Vegetables and fruits (total)	481	403	511	377	430	610
Irish potato	20	20	20	16	} 165	137
Sweet potato	23	9	4	17		28
Taro and poi	213	6	10	38		
Leafy, green, and yellow vegetables	18	58	88	77	80	100
Vitamin C fruits	60	74	49	56	50	90
Other vegetables and fruits	139	199	310	163	105	235
Legumes and legume products†	8	37	30	10	30	20
Meat, fish, and eggs	131	128	90	177	82	122
Fats	16	17	12	17	49	52
Sugars	57	40	39	39	35	60
Miscellaneous	29	50	43	21		

*Total represents the sum of fresh whole milk, plus evaporated milk multiplied by 2.
†For Japanese families, a large proportion was tofu and miso.

Cereal consumption of the Hawaiians was less than that of the Oriental groups because the Hawaiians obtained a considerable portion of their calories from taro and poi, which have about one-third more calories per unit of weight than potatoes. In fact, the Hawaiian per capita consumption of taro and potatoes on the pound basis exceeded the recommendations of the Bureau for potatoes by 55 percent. Potato consumption for all families is very low compared to figures for mainland families.

Consumption of meat, fish, and eggs for all groups exceeded recommendations. The per capita consumption of these protein foods by the Chinese was 55 pounds in excess of the recommendations for a moderate cost diet. (These figures confirm observations in nutrition classes at the University of Hawaii that students of Chinese ancestry often exceed other groups in their consumption of meat and fish.)

Fat consumption by all the groups was low.

Distribution of Total Calories. Table 4 shows the percentage distribution of calories among the various food groups—mean values for the four groups of families studied in Hawaii compared with the Bureau's recommended diets at two cost levels (*27*).

The Japanese families obtained too high a percentage of their calories from cereals because they depend upon rice as an important source of calories. The percentage of calories from vegetables and fruits appears low when compared with the mainland recommendations, but it should be kept in mind that the mainland figures include high-calorie vegetables, such as potatoes, whereas the Japanese use relatively small amounts of the high-calorie vegetables, such as potatoes and taro. The high percentage of calories derived from vegetables in the diets of the Hawaiian families is due to the use of taro and poi. (Taro has a higher caloric value per unit of weight than potatoes,

Table 4

Percentage Distribution of the Total Calories in the Diet among the Various Food Groups

	Number of families	DAILY INTAKE		PERCENTAGE DISTRIBUTION OF CALORIES				
		Per capita	Per adult male unit	Cereals	Vegetables and fruits	Milk and milk products	Meat, fish, and eggs	Fats and sweets
Hawaiian	48	2,335	3,135	35	22	7	13	21
Oahu Japanese	39	2,664	3,260	59	10	4	11	14
Kona Japanese	25	2,500	3,024	60	14	5	8	14
Chinese	5	1,851	2,626	29	37	7	19	6
Bureau of Home Economics (*27*, p. 3) recommendations								
Minimum cost diet				35	15	18	8	24
Moderate cost diet				24	18	19	12	27

and poi a lower value. Taro has a solids content of about 40 percent, poi 16 to 18 percent, and potatoes 22 percent.)

The percentage of calories obtained from meat, fish, and eggs by the Kona Japanese met the minimum cost recommendation of the Bureal of Home Economics. The other three groups on Oahu met or exceeded the Bureau's recommendation for the moderate cost diet.

The percentage of total calories furnished by milk and milk products was only about one third as great as the Bureau's recommendation for both minimum and moderate cost diets. Thus, evaluation of the diets on this basis, as well as the per capita consumption, shows a low intake of milk and milk products by these rural families. This is not surprising when one considers that the diets of the racial groups in this study have in the past included no milk after the period of maternal nursing. General observation of student diets and a comparison with previous figures for milk consumption by Japanese families in Hawaii (*14*) indicate a gradual increase in the use of milk and milk products.

Money Value of the Family Diets. The average per capita money value of all the diets for 28 days was $6.83. This was a little more than adequate for a satisfactory diet at prevailing prices in 1940 (*21*). Home-grown foods and food received as gifts, or otherwise obtained free, were listed at local current retail prices. As most of the records for this study were collected during 1939 and 1940, prices paid for food were small in comparison with today's prices. The Retail Food Price Index of the Department of Labor and Industrial Relations indicates that the price index for 1952 is approximately 180 as compared with an index of 100 in 1940. Table 5 shows the average total money value of the diets, the per capita value, and the percentage distribution of the food money among common food groups, for these families and for the Bureau's recommended distribution of family food money at two different cost levels (*27*).

The percentage of the food money spent by the Oahu families for vegetables and fruits compared favorably with the Bureau's recommendation for a minimum cost diet, whereas that of the Kona families compared well with the recommendation for a moderate cost diet.

All groups of families spent too much of their food money for meats and too little for milk. In the Japanese families too high a percentage of the food money was spent for cereals, according to the Bureau of Home Economics recommendations (*28*).

Average Daily Intake of Essentials, and Nutritive Adequacy. The average daily intake of calories, protein, calcium, phosphorus, iron, and vitamins A, B_1, and C for these families was calculated from their food consumption data. The results in terms of "adult male units" are presented in table 6.

The current recommended allowances of the National Research Council (*19*) are given in table 6, as well as the Bureau's allowances (*28*) used as the standard in this study. The allowances for calories, vitamin B_1 (thiamine), and vitamin C remain the same; those for protein, calcium, and vitamin A are slightly higher in the more recent recommendations. The allowance for iron has been lowered. The terms recommended allowances and recommended standards, or merely standards or allowances, are used interchangeably in this bulletin, all implying desirable levels of nutrients rather than actual requirements.

Table 5

Money Value of the Diets and Percentage Distribution of the Food Money among Common Food Groups

	AVERAGE VALUE OF FOOD PER 28 DAYS		AVERAGE NUMBER PERSONS IN FAMILY	PERCENTAGE DISTRIBUTION OF FOOD MONEY					
	Per family	Per capita		Cereals	Vegetables and fruits	Milk and milk products	Meat, fish, and eggs	Fats and sweets	Miscellaneous
	dollars	*dollars*							
Oahu Japanese	45.89	6.48	7.1	16.5	23.0	9.2	35.4	11.0	4.7
Hawaiian	48.40	6.99	6.9	20.3	20.7	7.2	34.2	8.8	8.7
Kona Japanese	46.00	6.02	7.6	24.8	27.7	6.0	25.0	8.7	7.9
Chinese	57.51	7.01	8.2	15.4	20.0	7.0	46.8	8.8	2.0
Bureau of Home Economics (*27*, p. 37) recommendations									
Minimum cost diet				15	20 - 25	30 - 35	15	15	
Moderate cost diet				10	25 - 30	25 - 30	15 - 20	15 - 20	

Table 6

Average Daily Intake of Dietary Essentials Per Adult Male Unit

	CALORIES	PROTEIN	CALCIUM	PHOSPHORUS	IRON	VITAMINS A I.U.	VITAMINS B I.U.*	VITAMINS C I.U.†
		gm.	*gm.*	*gm.*	*mg.*			
Hawaiian	3,135	76	.40	1.25	17	4,163	392	1,676
Oahu Japanese	3,260	82	.37	1.35	19	4,049	268	2,380
Kona Japanese	3,024	75	.34	1.18	18	5,314	247	1,608
Chinese	2,626	66	.28	1.0	14	5,200	317	1,992
Bureau of Home Economics allowances (for a moderately active man) (1939) (*28*)	3,000	67	.68	1.32	15	6,000	500	1,500
National Research Council allowances (1948) (*19*)	3,000	70	1.0	—	12	5,000	1.5 mg.	75 mg.

* One International Unit of Vitamin B_1 is equivalent to 3 micrograms of thiamine.

† One International Unit of Vitamin C is equivalent to 0.05 milligram of ascorbic acid.

Food composition figures from this Station and other laboratories were used in preparing the table. In calculating the nutritive value of the foods, the inedible portion of vegetables, fruits, and meats was taken into consideration. For many local foods the percentage refuse (inedible portion) as determined by the Foods and Nutrition Department of this Station was used. For others, the figures were taken from Rose (*23*). In the case of a food produced in large quantity at home for family use (such as taro, breadfruit, or mangoes) the percentage refuse was probably higher, as there was less need for economy and selection could be limited to the choicest parts.

The average adequacy of the diets, in terms of percentage plus or minus, for each essential for all groups of families is given in table 7. Each family's requirements for the eight dietary essentials, for the 28-day period studied, were calculated from the family composition and the number of meals eaten in the home by family members and guests. Each family's consumption of these essentials was compared with the recommended daily standards to

Table 7

Nutritive Adequacy of the Diets

	AVERAGE PERCENTAGE PLUS OR MINUS OF INTAKE COMPARED WITH RECOMMENDED STANDARDS (*28*)							
	Calories	Protein	Calcium	Phosphorus	Iron	VITAMINS A	VITAMINS B	VITAMINS C
Hawaiian	+ 4.5	+13.4	—41.2	— 5.3	+13.3	—30.6	—21.6	+11.7
Oahu Japanese	+ 8.6	+22.4	—45.6	+ 2.3	+26.7	—32.5	—46.4	+58.7
Kona Japanese	+ 0.8	+11.9	—50.0	—10.6	+20.0	—11.4	—50.6	+ 7.2
Chinese	—12.5	— 1.5	—58.8	—24.2	— 6.7	—13.3	—36.6	+32.8

determine the adequacy of the diet. For this calculation the daily inidividual dietary allowances, as given by the Bureau of Home Economics (*28*), were used.

Table 8 summarizes the number and percentage of family diets that were inadequate in each of the eight dietary essentials studied.

The data given in tables 7 and 8 provide the basis for certain generalizations and conclusions regarding the adequacy of the family diets. With the exception of the Chinese, the intakes of calories and of protein seem to have been adequate.

The protein for the Hawaiian families was 13.4 percent above the recommended allowances. The Oahu Japanese families averaged 22.4 percent above, the Kona families 11.9 percent above, and the Chinese 1.5 percent below. There were individual families in each group that did not have the calculated recommended allowances of protein: 22 Hawaiian families, 6 Oahu Japanese families, 7 Kona Japanese families, and 3 Chinese families. Obviously many families in each group consumed considerably more protein than they needed. For example, 7 of the Kona families and 9 in the Oahu group had protein intakes ranging from 40 to 108 percent above the amounts calculated to meet the recommended standards.

The calcium intakes were strikingly low in all groups; this was largely the result of low milk consumption. No Chinese family met the standards for calcium, and only one Hawaiian family, one Japanese family on Oahu, and one in Kona met or exceeded the standard for this important mineral.

The average vitamin A intakes for all groups were inadequate, judged by the Stiebeling and Phipard (Bureau of Home Economics) standards, which recommended 6,000 I.U. vitamin A daily for the standard man. But, compared with the present (1952) National Research Council dietary allowance of 5,000 I.U. of vitamin A for the standard man, the Kona Japanese and the Chinese are more than adequate; the mean for the Oahu Japanese families and that for the Hawaiian families are below the recommended standard.

After calcium, vitamin B_1 (thiamine) was the nutrient most often and to the greatest extent deficient. This deficiency was caused by the extensive use of refined cereals. (This study was made prior to the enrichment of bread and other cereals.) Only two of 64 Japanese families in the study had adequate or more than adequate thiamine. One of five Chinese families exceeded the standard because of their high consumption of pork. The mean thiamine content of the Hawaiian family diets was higher than that of the Japanese and Chinese family diets, because of their use of taro and poi. Nine of the 48 Hawaiian families met or exceeded the standards for thiamine. The consumption of taro and poi averaged 0.6 pound per person per day ("as purchased" weight). For the Hawaiian families living on the windward side of the Island of Oahu, whose average per capita daily consumption of taro was 0.9 pound, the average thiamine intake was only 5 percent below the standard allowance. In other parts of the island the average per capita daily consumption of taro, by Hawaiian families, was found to be only 0.3 pound. Among these families, the thiamine intake was 33 percent below the standard allowance—making an average, for all the 48 Hawaiian families, of about minus 20 percent. The Japanese families used very little taro and less potatoes and sweet potatoes (both rich in thiamine) than the Hawaiiian families. They used more refined cereals (practically devoid of thiamine) than the Hawaiian families. Both groups used very little whole-grain cereal foods.

Table 8

Number and Percentage of Family Diets Deficient* in Each of the Eight Dietary Essentials

	CALORIES	PROTEIN	CALCIUM	PHOSPHORUS	IRON	VITAMINS		
						A	B	C
Number of family diets deficient in the various essentials								
Hawaiian	22	22	47	31	20	42	39	26
Oahu Japanese	16	6	36	22	6	33	38	11
Kona Japanese	11	7	24	16	4	18	24	11
Chinese	3	3	5	4	3	2	4	2
Percentage of family diets deficient in the various essentials								
Hawaiian	46	46	98	65	42	88	81	54
Oahu Japanese	41	15	92	56	15	85	97	28
Kona Japanese	44	28	96	64	16	72	96	44
Chinese	60	60	100	80	60	40	80	40

* Deficient means failure to meet the recommended allowances (*28*).

The means for vitamin C in table 6 would indicate adequate intakes of this vitamin for all families, but again we find individual families that had intakes below the recommended allowances. A little less than half the Hawaiian families, about two thirds the Oahu Japanese, more than half the Kona Japanese families, and three of the five Chinese families had adequate or more than the standard allowance of vitamin C. The remainder did not meet the calculated standards, even though fruits and vegetables high in vitamin C are abundant and can be readily raised or purchased in Hawaii.

Table 8 shows the number of diets and the percentage of all family diets that are deficient in each of the eight dietary essentials. (The term dietary deficiency is used here to mean failure to meet the recommended daily dietary allowances and not that the members of the families actually showed clinical signs of a deficiency.) About half of all family diets were deficient in calories. (This is true despite the fact that in table 6 the mean values for the groups indicate adequate calories. Families with excess calories tended to cancel out those with low intakes.) An equal number of diets in the Hawaiian and Chinese groups were deficient in protein. Only one Hawaiian, three Oahu Japanese, and one Kona Japanese family had calcium intakes meeting the recommended standard. About half the Hawaiian and Japanese and four fifths of the Chinese had insufficient phosphorus. About half the Hawaiian and Chinese families had too little iron. About three fourths of the Hawaiian and Japanese families had an insufficient amount of vitamin A. Only nine Hawaiian, two Japanese, and one Chinese family had sufficient thiamine. About half the Hawaiian, Kona Japanese, and Chinese families had too little vitamin C.

Table 9 shows the average number of dietary deficiencies per diet. (The term dietary deficiency is used here to mean failure to meet the recommended daily dietary allowances, not that the members of the families actually showed clinical signs of a deficiency.) The average number is 5.2 for the diets of the Hawaiian and the Chinese families and 4.1 for the diets of the Japanese families. Only one family diet was up to standard in all eight dietary essentials; a few were very nearly adequate.

Figure 1 gives a graphic representation of the percentage distribution of the four groups of family diets among four dietary classes.

Table 9

Number of Families Whose Diets Failed to Meet the Recommended Standards

NUMBER OF DIETARY ESSENTIALS INADEQUATE ⟶	0	1	2	3	4	5	6	7	8	AV.
Hawaiian	0	2	6	8	5	2	5	9	11	5.2
Oahu Japanese	0	3	4	7	7	8	4	4	2	4.1
Kona Japanese	1	0	1	5	6	3	4	5	0	4.1
Chinese	0	1	0	1	0	0	1	0	2	5.2
Totals	1	6	11	21	18	13	14	18	15	

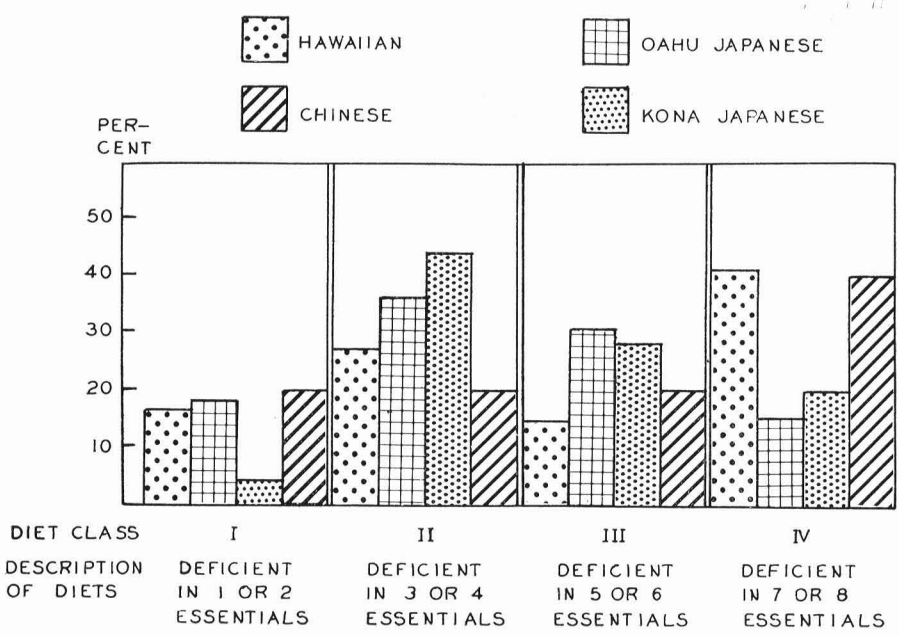

Figure 1. Percentage of family diets in each of four dietary classes.

Relationship Between Nutritive Adequacy and Cost. Figure 2 shows some degree of positive correlation between the per capita cost and the nutritive adequacy of the diet. The more money a family spends for food, the more nearly adequate the diet tends to be; low-cost diets are more likely to be deficient than those of higher money value. However, many of these family diets could have been nutritionally adequate if less of the food money had been spent for refined foods and more for protective foods (milk, vegetables, fruits, whole-grain cereal products). About one third of the families were spending too little money for food. To make the diets adequate in these cases, more of the family income should have been used for food, or home gardens should have supplied more food for the family.

Home-Grown Foods. Table 10 shows the average amount of home-produced foods for family use, in pounds per family per 4-week period. Twenty families produced no foods for home use. Five families had milk cows; 67 families had chickens; 92 families produced vegetables for home use; and 77 families had fruit trees producing fruit at the time of the study. A number of the Hawaiian families on Oahu and the Japanese families in Kona obtained fish and shellfish by fishing or as gifts.

NUTRITIONAL STATUS OF CHILDREN

Weights and Heights of Children in Co-operating Families. There are various means of assessing the physical fitness of children from their body measurements (*11*). Two well-known standards were used in this study—the Baldwin-Wood Tables (*2*) and the Pryor Width-Weight Tables (*22*).

As noted by Jenss and Souther (*11*), the Baldwin-Wood Tables are indices of body build and "estimate a boy's or girl's weight in terms of his or her height (to the nearest inch) used as a criterion of body build at a given age (taken at the nearest birthday)," and "were developed to identify a boy or girl who is *underweight* for his or her body build judged in terms of height."

"The Pryor Tables estimate the average weight of a boy or girl of a given age (at nearest birthday) and body build, judged in terms of his or her height (to the nearest inch) and bi-iliac diameter" (hip width), and again are used

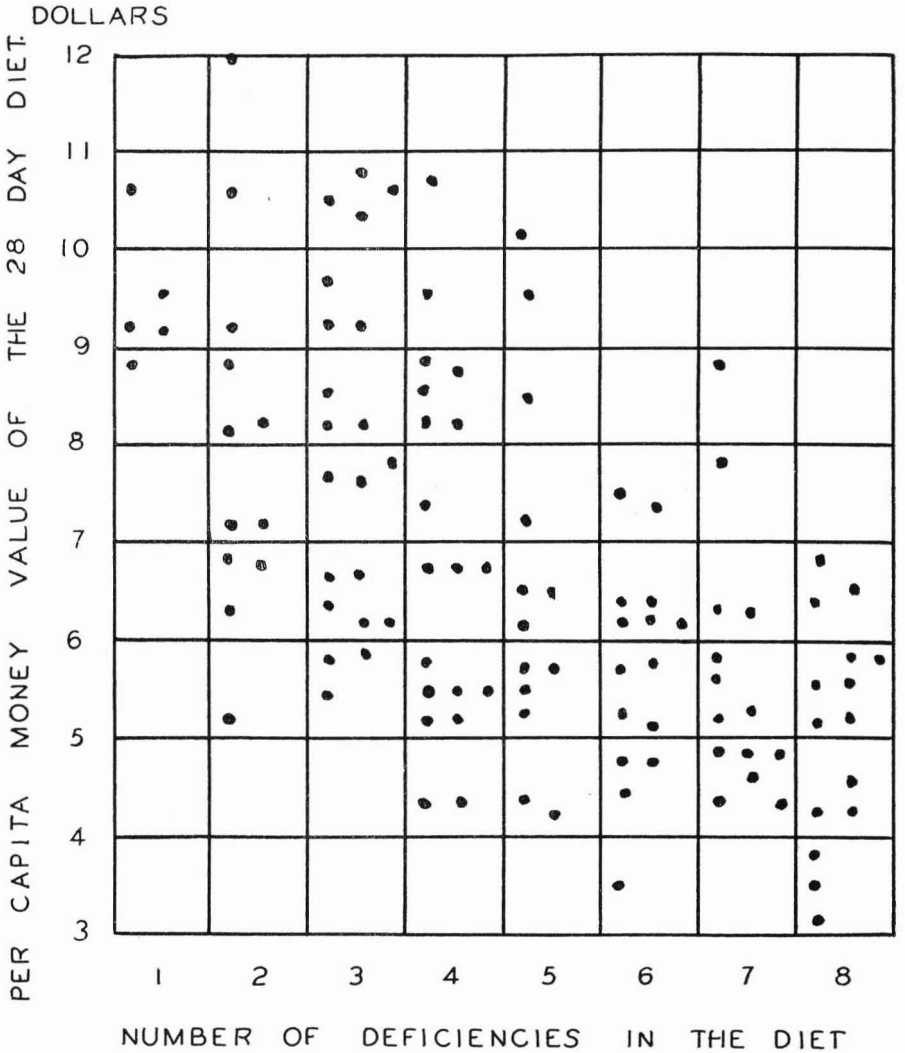

Figure 2. Scatter diagram showing relationship between per capita cost and nutritional adequacy of the diet.

Table 10
Average Number of Pounds of Home Produced Food
Per Family Per 28 Days

	VEGE-TABLES	FRUIT	EGGS	POULTRY	MILK	FISH
Hawaiian	74	24	1.7	1.3	0.1	13.8
Oahu Japanese	37	27	5.9	4.1	2.3	1.8
Kona Japanese	79	99	6.0	3.4	61.0	13.4
Chinese	20	8	26.9	9.0	—	—

to identify a boy or girl who is underweight for his or her body build, judged in terms of height and bi-iliac diameter (*11*).

The deviation of the actual weight from the expected weight, according to the two standards just described, was calculated for each child.

In table 11 the average weights for the children in each of the four groups of families are compared with the two standards (Baldwin-Wood and Pryor) and with other studies of children of Hawaiian and Japanese ancestry. These are indicated by the percentage deviations from the standards and from weights in the previous studies.

In this study, the Hawaiian children averaged about 3 percent above the Baldwin-Wood standards for weight, the Japanese children 2 percent below, and the Chinese 8 percent below (table 11). The weights of the Hawaiian and the Japanese children were about 7 and 4 percent, respectively, above the Pryor standards (*22*). The Hawaiian children were 4 percent heavier and the Japanese 9 percent lighter than the children of "old American" stock recorded by Collins and Clark (*4*). The Hawaiian children were 3 percent heavier, and the Japanese 10 percent heavier, than children of their own racial groups in Hawaii in 1920–21, as recorded by Wissler (*38*). Japanese infants (birth to 2 years) in this group are 4 percent heavier than Japanese infants in Hawaii weighed by Appleton in 1925 (*1*). They are 8 percent heavier than Japanese infants in Japan reported by Takagi *et al.* in 1937 (*31*).

The mean percentage deviations in weight for height of the children of Japanese ancestry at each age level are shown in table 12. These data are shown graphically in figure 3 for the Baldwin-Wood and for the Pryor standards. (The average deviations for three 9-year-old girls and for four 15-year-old girls were omitted in the graphs as they were much out of line with those for the other children in the group.)

In the comparison with the Baldwin-Wood standards, the weight deviations are largely on the minus side, though the mean deviations for the boys are less than those for the girls (fig. 3). From 2 to 4 years of age the Japanese children are not appreciably below the Baldwin-Wood standards, but during the fifth and sixth years they tend to fall considerably below these standards for American children.

Table 11

Percentage Deviation in Weights of Children in Hawaii (This Study) from Weights of Other Groups of Children of the Same Age

	NUMBER OF CHILDREN (1938-41) (1-18 YEARS)	BALDWIN-WOOD STANDARDS (*2*) (1-18 YEARS)	PRYOR STANDARDS (*22*) (1-18 YEARS)	COLLINS AND CLARK'S "OLD AMERICAN STOCK" (*4*) (6-15 YEARS)	CHILDREN IN HAWAII WEIGHED BY WISSLER, 1920-21 (*38*) (7-18 YEARS)		CHILDREN IN HAWAII WEIGHED BY APPLETON, 1925 (*1*) (1-24 MONTHS)	JAPANESE CHILDREN IN JAPAN, 1937 (*31*) (1-24 MONTHS)
					Hawaiian	Japanese	Japanese	
Hawaiian	256	+3.3	+7.2	+4	+3			
Oahu Japanese	149	—2.3	+3.9	—9		+10	+4	+8
Kona Japanese	118	—2.2	+3.5					
Chinese	27	—8.3	—0.3					

Table 12

Percentage Deviations (plus or minus) of the Weights of the Japanese Children from Two Standards—Baldwin-Wood and Pryor—by Age Groups

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Baldwin-Wood																			
Male	+ 4.70	+1.10	—0.82	—4.20	—5.83	—1.67	—2.20	— 1.84	—4.73	+ 1.15	—1.16	—2.24	—1.06	— 1.60	—0.72	+0.30	—2.73	—18.10	+3.63
Female	— 2.02	+2.50	+1.70	—3.47	—8.80	—3.78	—6.81	+ 8.40	—4.45	— 7.63	—5.56	—2.88	—4.40	—12.25	+0.43	+1.04	—0.90	— 1.20	—7.18
Pryor																			
Male	+13.88	+4.97	+2.75	+0.32	+1.61	+6.21	+5.09	+ 6.98	+4.61	+10.87	+1.60	+0.90	+4.24	+ 2.93	—0.40	+5.83	+3.06	—10.00	—1.80
Female	+ 0.20	+3.16	+7.60	+1.18	—2.64	+4.71	—0.33	+17.53	+3.62	+ 0.85	+1.84	+4.51	+2.00	— 8.12	+5.65	+6.38	+3.90	+ 5.80	—3.48

On the other hand, the trend of the plus deviation in weights from the Pryor Tables (fig. 3) indicates that the children of Japanese ancestry are not underweight for their hip width and suggests that they are a different type of build from the American children on which both the Baldwin-Wood and the Pryor Tables were based.

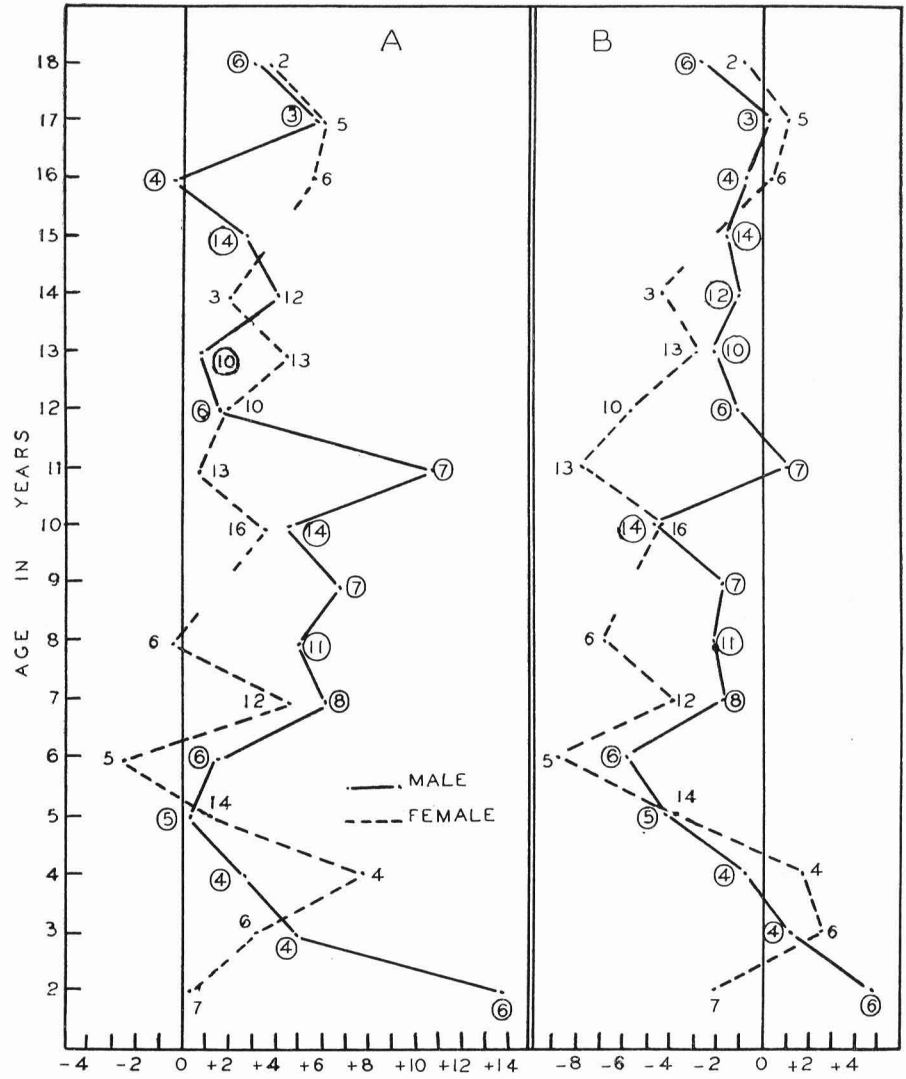

Figure 3. A, Mean percentage deviations from the Pryor standards of the weights for heights of Japanese children; B, mean percentage deviations from the Baldwin-Wood standards of the weights for heights of Japanese children. (Numbers represent the number of subjects at each age level.)

Table 13

Percentage Distribution of Children among the Six Classifications of Nutritional Status

	G_1	G_2	F_1	F_2	P_1	P_2
Hawaiian	47	20	13	8	5	7
Japanese	26	31	21	11	6	5

When the heights of children in this study were compared, the Hawaiian children averaged 4 percent taller than the Japanese children. When compared with other groups of children, the Hawaiian children averaged 1 percent taller and the Japanese children 3 percent shorter than the "old American" stock, as measured by Collins and Clark (*4*). The Hawaiian children of today averaged 1 percent taller and the Japanese 4 percent taller than the children of the same racial stocks in Hawaii 20 years ago (*38*).

The weight, height, and age tables of Woodbury for children 2, 3, and 4 years old and of Baldwin-Wood for school children 5 to 18 years old, both as published in Rose's Laboratory Handbook for Dietetics (*23*), were used to show normal zones (range of weights and heights) in figures 4 and 5. (The estimated figures for weight and height, which extend the ranges for each age and which are starred in the Baldwin-Wood Tables, were not used.) The dots represent the actual weights and heights of all the Japanese children in this study from 2 to 18 years, inclusive.

It is clear that most of the weights and heights for both boys and girls fall within the normal zones for each age. In no case do any heights fall above the zones of normality, and for only two boys 2 years of age and one girl 5 years of age do the weights fall above the normal zone. The tendency is for the dots to fall in the lower sections of, or below, the zones indicating normal weights and heights.

More girls than boys are below the zones in both weight and height—31 percent of the 129 girls and 22.4 percent of the 125 boys are below the zones for weight; 15.5 percent of the girls and 9.6 percent of the boys are below the zones for height.

Nutritional Ratings of Children. Every child was given a nutritional rating based on the findings in the general physical examination. The children were divided into six successively poorer groups as to nutritional status. The six ratings were as follows:

G_1—good nutritional condition in every respect; no signs of skeletal defects.

G_2—good present nutritional condition; mild signs of defective early skeletal development.

F_1—fair present nutritional condition; mild signs of defective early skeletal development.

F_2—fair present nutritional condition; multiple or serious signs of defective early skeletal development.

P_1—poor present nutrition; mild signs of defective early skeletal development.

P_2—poor present nutrition; multiple or serious signs of defective early skeletal development.

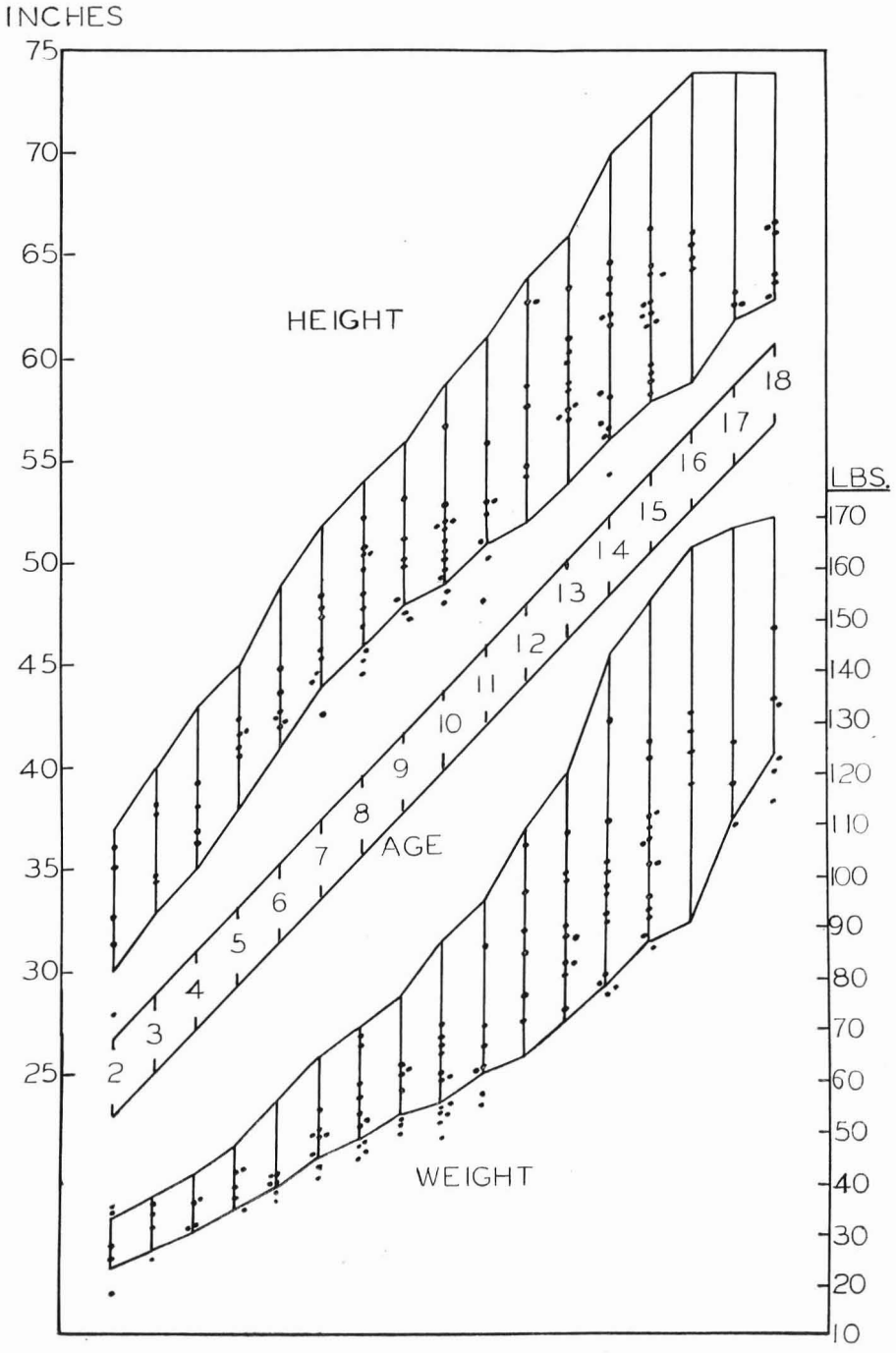

Figure 4. Weights and heights of Japanese boys and normal zones of weights and heights from Woodbury and Baldwin-Wood tables. (Each dot represents the weight or height of one subject.)

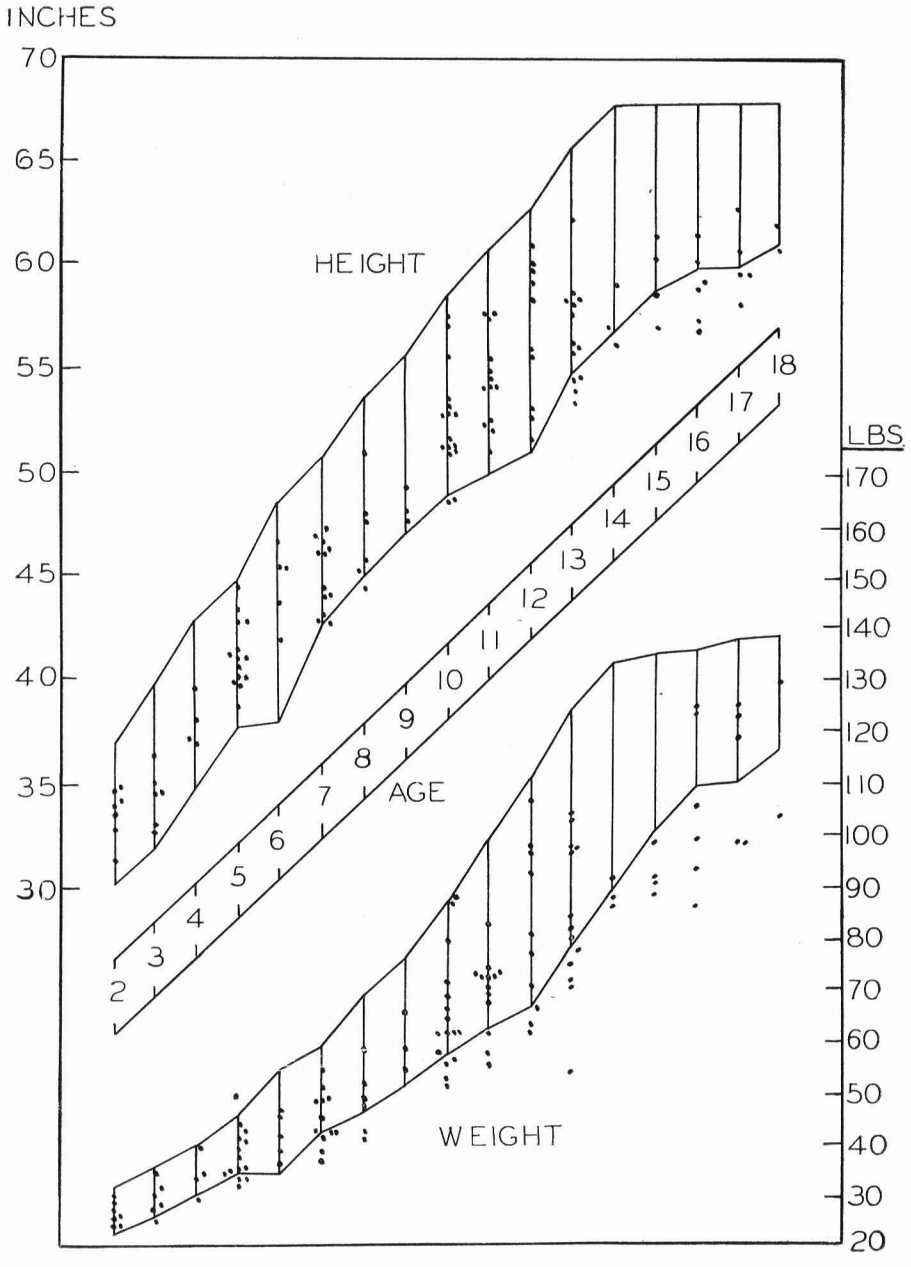

Figure 5. Weights and heights of Japanese girls and normal zones of weights and heights from Woodbury and Baldwin-Wood tables. (Each dot represents the weight or height of one subject.)

Table 14

Percentage Distribution of Children among Three Grades of Skeletal Development

	GOOD SKELETAL DEVELOPMENT (G_1)	MILD SIGNS OF DEFECTIVE SKELETAL DEVELOPMENT (G_2, F_1, P_1)	MORE SERIOUS SIGNS OF DEFECTIVE SKELETAL DEVELOPMENT (F_2, P_2)
Hawaiian	47	38	15
Japanese	26	58	16

The percentage distribution of the children among the six classifications as to nutritional status is given in table 13. Sixty-seven percent of the Hawaiian children and 57 percent of the Japanese children were classed as being in a "good" (Groups G_1 or G_2) nutritional state.

Those rated as G_2, F_1, and P_1 showed slight signs of poor skeletal development. Those rated as F_2 and P_2 showed more serious signs of defective skeletal development. Those rated as G_1 showed none. In table 14 the children are grouped as to grades of skeletal development.

Relationship Between Weight and Nutritional Rating of Children. Tables 15 and 16 show the relationship, in these children, between nutritional rating and percentage deviation from two weight standards—Baldwin-Wood and Pryor. For the Hawaiian children the Baldwin-Wood standard (based on height, age, and sex) seems to be the more satisfactory to use as a measure of nutritional development, if any can be so used, than the Pryor standard (based on hip width, height, age, and sex). For the Japanese children the Pryor standard seems to be more satisfactory than the Baldwin-Wood.

Relationship Between Skeletal Development and Dental Status. Table 17 shows the average number of defective teeth per child of children with good, slightly poor, or poor skeletal development. In the first two age groups, 1 to 5 and 6 to 10 years, the children with good skeletal development tended to have fewer defective teeth per child than did those with poor skeletal development. For the two older age groups, 11 to 15 and 16 to 20 years, those with poor

Table 15

Percentage of Children above (plus) or below (minus) the Baldwin-Wood Standards in Weight, in Relation to the Nutritional Rating Groups

	G_1 AND G_2	F_1 AND F_2	P_1 AND P_2
Hawaiian	69+	55+	45+
	31—	45—	55—
Japanese	49+	23+	23+
	51—	77—	77—

Table 16

Percentage of Children above (plus) or below (minus) the Pryor Standards in Weight, in Relation to the Nutritional Rating Groups

	G_1 AND G_2	F_1 AND F_2	P_1 AND P_2
Hawaiian	85+	74+	61+
	15—	26—	39—
Japanese	79+	64+	47+
	21—	36—	53—

Table 17

Relationship between Skeletal Development and Dental Defects

AGE GROUPS IN YEARS	AVERAGE NUMBER OF DEFECTIVE TEETH PER CHILD ASSOCIATED WITH VARIOUS GRADES OF SKELETAL DEVELOPMENT					
	GOOD		SLIGHTLY POOR		POOR	
	Hawaiian	Japanese	Hawaiian	Japanese	Hawaiian	Japanese
1– 5	2.4	5.4	3.7	5.1	4.1	8.1
6–10	8.2	9.5	8.9	10.0	6.1	11.8
11–15	7.9	9.9	8.0	9.0	8.0	8.2
16–20	7.9	12.3	8.0	11.4	8.0	12.0

skeletal development had no more defective teeth than those with good skeletal development. Some children were found to have good skeletal development and extensive dental decay, while some with poor skeletal development had relatively good teeth.

DENTAL STATUS OF CHILDREN

This section was written by Carey D. Miller, head of the Department of Foods and Nutrition, University of Hawaii College of Agriculture, and approved by Dr. Dorothy Dudley. The original data on the dental cards were completely retabulated and summarized in 1952, with the assistance of Hazel C. Murray and Mildred Higa.

The dental condition of the 545 children and youths in these families, between the ages of 2 and 20 years, are shown in table 18.

Dental Caries. The D.M.F. rate per subject, employed by many investigators, has been used to compare the different age groups within racial groups and to compare those of Hawaiian and Japanese ancestry. As pointed out by Hadjimarkos and Storvick (*8*), "It is generally agreed today that a dependable and accurate index of the caries experience in the permanent teeth of school children can be obtained by a summation of decayed, missing, and filled teeth. For reasons of brevity, the figure derived from such measurements is com-

monly referred to as the D.M.F. rate." They suggest further that the condition of the first permanent molars provides a good measure of susceptibility to dental caries.

As there were too few children in each yearly group from 2 to 20 to consider the average figures as representative, they were grouped arbitrarily by combining both sexes and several ages. Those aged 2 to 5 years were placed in one group as comprising the preschool ages. Children 6 to 14 were classified into three groups, each group including three ages (see tables 18 and 19). Because there were few boys and girls in each age group over 15, all those 15 to 20 years were placed in one group. There are 17 to 81 in each of the Hawaiian and Japanese groups—numbers sufficiently large to clearly indicate trends.

Ninety-eight percent of the Hawaiian and 100 percent of the Japanese and Chinese children over 5 years of age had defective teeth.

From table 18 it may be noted that 35 children and youths, or a little more than 6 percent of a total of 545, had perfect teeth. For the Hawaiians, 25 of these were in the 2-to-5 age group, and, actually, 23 were less than 4 years of age. Of the 116 subjects of Japanese ancestry living in the Kona district of Hawaii, only 3 (all under 3 years of age) had perfect teeth. On Oahu there were also only 3 of the 152 Japanese children that had perfect teeth, and they too were all less than 3 years of age.

The mean D.M.F. rates per subject for the Japanese groups on Oahu and Kona are similar, whether we include all subjects from 2 to 20 (Oahu 9.92, Kona 9.95) or whether we include only those from 6 to 20 (Oahu 10.33, Kona 10.48). The mean D.M.F. rates for all the Hawaiians are lower than those for the Japanese, whether we group them from 2 to 20 (248 subjects, D.M.F. rate 7.04), or whether we include only 6 to 20 (167 subjects, D.M.F. rate 8.35).

The marked rise in the D.M.F. rate for ages 6 to 8 in the four racial groups shown in table 18 and the significant decrease in the next older age group may be accounted for by the bad condition of the deciduous teeth and their gradual replacement with permanent teeth. The latter soon become carious, and the D.M.F. rate rises, especially in the 15- to 20-year group.

Abscessed teeth were not uncommon, especially for the two younger age groups (table 18). In all four racial groups, ages 6 to 8 seemed to be the period when abscessed deciduous teeth were most serious, varying from a mean per subject of 1.29 for the Hawaiian to 4.60 for the small group of Chinese children.

The children of Japanese ancestry living in Kona had slighty better deciduous teeth than the Oahu Japanese, judging from the D.M.F. rates per subject for the 2- to 5-year group as well as from the number of abscessed teeth. However, by the time the children reached the ages of 12 to 14 and 15 to 20, the D.M.F. rates were quite similar, although the number of permanent teeth that were abscessed was considerably greater in the Oahu group than in the Kona group. These conditions are probably attributable to both past nutritional history and present food habits as well as to lack of dental care. Most families in Kona use rain water for drinking, so it could not have been a more favorable fluorine content of the water that had influenced the Kona children's teeth for the better.

First Permanent Molars. The first permanent molars (the 6-year molars) have been called by many, including the American Dental Association, "the

Table 18

Dental Status of Children

GROUPS AND AGES	TOTAL NUMBER IN EACH GROUP	NUMBER WITH CARIOUS TEETH	NUMBER WITH PERFECT TEETH	D.M.F. TOTAL	D.M.F. PER SUBJECT	ABSCESSED DECIDUOUS TEETH		ABSCESSED PERMANENT TEETH OTHER THAN FIRST MOLAR
						Total Number	Per Subject	
Hawaiian								
2–5	81	56	25	348	4.30	24	.29	0
6–8	58	57	1	491	8.46	75	1.29	0
9–11	50	50	0	368	7.36	36	.72	1
12–14	39	38	1	336	8.62	2	.05	2
15–20	20	19	1	201	10.05	0	—	4
Oahu Japanese								
2–5	31	28	3	258	8.32	62	2.00	0
6–8	28	28	0	336	12.00	90	3.21	1
9–11	33	33	0	298	9.03	17	.51	1
12–14	33	33	0	310	9.39	2	.06	2
15–20	27	27	0	306	11.33	0	—	6
Kona Japanese								
2–5	17	14	3	116	6.82	7	.41	0
6–8	24	24	0	322	13.41	69	2.87	0
9–11	22	22	0	188	8.54	19	.86	1
12–14	29	29	0	276	9.51	0	—	2
15–20	24	24	0	252	10.50	0	—	1
Chinese								
2–5	4	3	1	27	6.75	9	2.25	0
6–8	5	5	0	82	16.50	23	4.60	0
9–11	6	6	0	52	8.66	14	2.33	0
12–14	5	5	0	34	6.80	3	.60	0
15–20	9	9	0	103	11.44	0	—	0

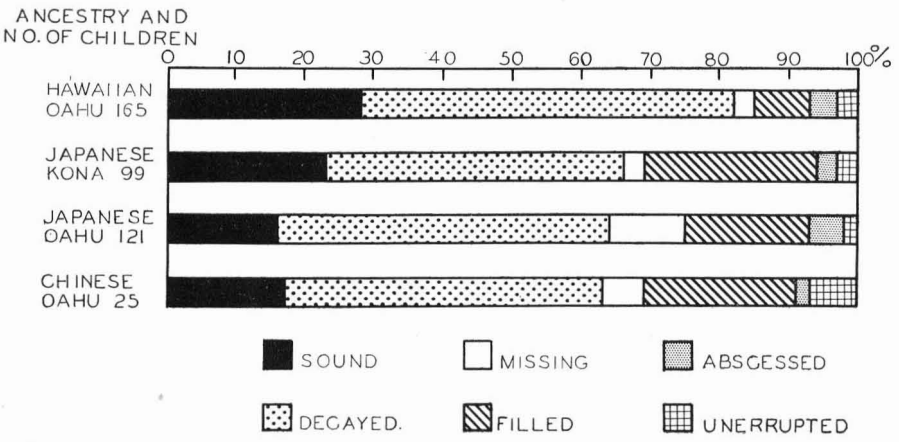

Figure 6. Condition of first molars, ages 6 to 20 years.

most important teeth in the mouth." Because they appear at an early age (usually 5 to 7 years), parents sometimes regard them as temporary teeth and neglect their care. These four molar teeth are vital to good dental health, not only because they provide the most important chewing surfaces, but because their position in the mouth governs the position of other teeth in the jaw. The condition of the first molars is, therefore, of great interest to all who are concerned with dental health.

In table 19 the condition of the first permanent molars of 418 subjects are summarized, and in figure 6 these data are depicted graphically.

Only 28 percent of the first molars in 165 subjects of Hawaiian ancestry were sound, and it may be noted that most of these were in the 6-, 7-, and 8-year-old children. Lack of dental care is indicated by the figures of 53.5 percent decayed, only 8.0 percent filled, and 4.4 percent abscessed.

Judging from the condition of the first molars (table 19), the Kona children had better teeth than the Oahu Japanese. For example, 22.7 percent of the first molars in the Kona group and only 16.5 percent in the Oahu group were sound. Kona Japanese had 2.5 percent missing and 2.5 percent abscessed, whereas the Oahu group had 11.4 percent missing and 5.2 percent abscessed. With continued neglect, those abscessed would have to be extracted, thus adding to the percentage of missing teeth. Better dental care among the Kona children is indicated by the figures on percentages of filled teeth—25.3 percent, as compared to 17.8 percent for the Oahu children.

Although the Hawaiians had the greatest percentage of sound first molars (table 19) the Hawaiian children, ages 9 to 14, had the greatest percentage of first molars found to be abscessed—6.7 percent. The Oahu Japanese for these two age groups (9 to 14) had the next greatest—5.7 percent abscessed—whereas the Kona Japanese had only 4.4 percent abscessed first molars.

The number of missing first molars for these subjects undoubtedly increased with age, judging from studies of 205 young men and women of Japanese ancestry, average age 19 years, at the University of Hawaii (*16*). The University students had about 20 percent of their first molars missing compared to 2.5 percent for the Kona Japanese group and 11.4 percent for the Oahu

Table 19
Status of the First Permanent Molars

	AGE GROUP	NUMBER OF SUBJECTS	CONDITION OF FIRST MOLARS					
			Sound	Decayed	Missing	Filled	Abscessed	Unerupted
Hawaiian	6–8	58	94	102	0	13	1	22
	9–11	50	30	150	2	9	9	0
	12–14	37	34	74	5	20	15	0
	15–20	20	28	27	10	11	4	0
	over 20	0	0	0	0	0	0	0
	6–20	165	186	353	17	53	29	22
Percent*			28.2	53.5	2.6	8.0	4.4	3.3
Oahu Japanese	6–8	28	36	64	0	2	2	8
	9–11	33	11	79	4	28	10	0
	12–14	33	19	56	22	30	5	0
	15–20	27	14	31	29	26	8	0
	over 20	(4)	(3)	(2)	(8)	(3)	(0)	0
	6–20	121	80	230	55	86	25	8
Percent*			16.5	47.5	11.4	17.8	5 2	1.6
Kona Japanese	6–8	24	28	54	0	2	0	12
	9–11	22	19	52	1	10	6	0
	12–14	29	23	44	6	40	3	0
	15–20	24	20	24	3	48	1	0
	over 20	(3)	(1)	(3)	(3)	(5)	(0)	0
	6–20	99	90	174	10	100	10	12
Percent*			22.7	43.9	2.5	25.3	2.5	3.0
Chinese	6–8	5	7	4	2	0	0	7
	9–11	6	3	19	0	0	2	0
	12–14	5	3	12	1	4	0	0
	15–20	9	4	11	3	18	0	0
	over 20	(1)	(1)	(0)	(1)	(2)	(0)	0
	6–20	25	17	46	6	22	2	7
Percent*			17.0	46.0	6.0	22.0	2.0	7.0

*Percentage of first molars affected, ages 6 to 20, inclusive.

Japanese group, ages 6 to 20 years. These figures, like those for abscessed first molars, suggest that the children of Japanese ancestry in the Kona area had better dental care and/or better food habits than the rural group studied on Oahu.

The serious condition of the first molars in these children illustrates dramatically the great need for the combined efforts of nutritionists, dental hygienists, and dentists to educate the parents, teachers, and children regarding these important teeth.

According to Schour and Massler (*25*), the organic framework of the first molars is laid down before birth, and at birth calcification has just begun; therefore, the nutrition of the child throughout the first 6 years vitally affects the structure of these teeth. Continued good food habits and early dental care can do much to reduce the high mortality of the first molars of the people of Hawaii.

Comparisons of Dental Conditions of Children in This Study with Other Dental Data. In table 20 the data on the D.M.F. rates of children in this study are compared with a more extensive study in Hawaii done about 10 years later, with data from the mainland United States, and with another semi-tropical area, namely, the Virgin Islands. The age groups are not identical, but contrasts are clearly evident.

Data gathered on four of the main islands of the Hawaiian group by the Division of Dental Health Education of the Department of Public Instruction in 1949–50 were analyzed by Dr. R. J. Fanning (*6*). The dental cards for ages 6, 8, 10, 12, 14, and 16 were used. As there is an increasing rate of

Table 20

Comparative Incidence of Dental Caries in Hawaii and Other Geographic Areas

SUBJECTS AND DATES OF STUDIES	NUMBER OF SUBJECTS	AGES	D.M.F. PER SUBJECT
Hawaiian			
(This study) (1938–41)	167	6–20	8.35
Fanning (1949-50) (*6*)	914	6–16	11.2
Japanese			
(This study) (1938–41)			
Oahu	121	6–20	10.33
Kona	99	6–20	10.48
All Islands (1949–50) Fanning (*6*)	2,576	6–16	14.6
Oregon (1948) (*8*)			
Clatsop County	177	14–16	14.4
Klamath County	214	14–16	9.0
Virgin Islands (1948) (*26*)	823	6–18	7.7
United States			
Michigan (1945)	9,641	12–14	9.31
New Jersey (1946) (*7*)	14,920	12–14	6.95
Minnesota (1947)	679	12–14	6.29

tooth destruction with age (*10*) one might expect to find that our group would have more dental defects because they include the years from 6 to 20. However, as can be seen from table 20, Dr. Fanning's figures for all the Islands (1949–50) show a higher D.M.F. rate than do the boys and girls examined in this study (1938–41).

The D.M.F. rate for 167 part-Hawaiians, ages 6 to 20, in 1938 to 1941, was 8.35; for 914 part-Hawaiians, ages 6 to 16, in 1949 to 1950, it was 11.2. For the children of Japanese ancestry there also appeared to be an increase in dental defects. The 220 Japanese children in Kona and Oahu between 6 and 20 years of age had 10.48 and 10.33 D.M.F. per subject, respectively (1938–41); in 1949 to 1950, 2,576 Japanese between the ages of 6 and 16 had a D.M.F. rate of 14.6. If the children examined in this study were truly representative, a considerable increase in dental decay had taken place in 10 years.

Students 14 to 16 years old in two areas of Oregon showed D.M.F. rates of 14.4 and 9.0. It would be expected that these youths would show a higher rate of dental decay than groups 6 to 14 and 6 to 20, because of increased dental decay with age. Though the age groups do not permit completely satisfactory comparisons, it is obvious that both Hawaii and Oregon have serious dental problems.

The data on dental caries for large numbers of children 12 to 14 years of age in three mainland states, given in table 20, are taken from a summary prepared by Fulton (*7*). When the D.M.F. rates for these children are compared with our three Hawaii groups, ages 6 to 20 (table 20), Hawaii appears to have a much higher D.M.F. rate per subject, but, when compared with ages 12 to 14 in table 18, the teeth of children of Japanese ancestry in Hawaii in 1938–41 were on a par with those in Michigan in 1945 and much worse than those in New Jersey and Minnesota in 1946 and 1947.

Gingivitis. Only about 30 cases of gingivitis were noted among the school children in this study.

Other Oral Conditions. About three fourths of all children above 2 years of age had other than normal occlusion. Only about one fifth were rated as "good" in oral hygiene. Over half showed serious lack of personal care of the teeth.

ADEQUACY OF FAMILY DIETS AND NUTRITIONAL STATUS OF CHILDREN

In this group of families it was difficult to measure the effect of the diet in general, or of certain dietary constituents, on the nutritional status of the children in the families, because all the family diets were somewhat similar in degree of inadequacy. Only one family diet was completely adequate, according to accepted standards. Almost all the diets were seriously deficient in calcium and in vitamin B_1, moderately low in vitamin A, and approximately adequate in calories, protein, phosphorus, iron, and vitamin C. Milk consumption was low in all families; the intake of vegetables, fruit, cereals, and meat was similar in all the families and did not differ widely from the recommended levels of intake.

In the nutritional status of the children there was also a lack of wide variation. None was extremely malnourished, and few, if any, could be considered ideally nourished, if all the physical factors studied are taken into

consideration. However, the effect of the level of intake of certain dietary constituents on physical traits in children was evaluated. Deviation in weight from standards, nutritional rating based on clinical examination, skeletal development, and the number of defective teeth per child at various age levels were contrasted between two groups of families whose diets varied in their content of certain constituents. Although these differences in physical characteristics are slight (with the exception of dental status in the 1- to 5-year age group), they indicate better health, growth, and dental status in the children who had better diets.

Influence of Diet on Weight. In those families whose diets were most nearly adequate in vitamins A, B_1, and C, the average deviation of children's weight from the Baldwin-Wood standards was plus 4 percent, as compared with zero for the children in those families whose diets were more seriously deficient in these vitamins. In the families whose calorie consumption was near the standard, the children averaged a plus 3 percent deviation from the Baldwin-Wood weight standards. In those families whose diets were deficient in calories the average deviation was minus 2 percent. Children averaged 3 percent heavier and 2 percent taller in those families whose diets were not more than 20 percent deficient in calcium, as compared with the children in those families with a seriously deficient calcium intake.

Influence of Diet on Nutritional Rating of Children. Comparisons were made between the average numerical nutritional ratings (see page 29) for the children in two groups of families whose diets differed in their degree of inadequacy of certain dietary essentials. In all instances the more nearly adequate family diets coincided with better nutritional ratings, particularly in the younger children (1 to 10 years of age), as compared with those over 10. There are many possible, but two obvious, reasons for this apparent difference in the influence of diet on nutritional status in the two age groups. One is that the family diets at present are more nearly representative of the food intake of the younger group over the past few years than they are of the diet of the older group when they were small. In other words, family diets have probably suffered during the past decade (become higher in refined, processed, and commercial foods and lower in home-produced foods), and the health of the younger children (as compared with that of the older ones) reflects this change for the worse. It is becoming increasingly convenient for rural families to secure commercially prepared foods, and mothers are now more frequently working for salaries outside the home. The other reason for the better nutritional state of the older child, as compared with the younger child, in families whose diets are more seriously deficient, lies within the child. In the early part of adolescence a more rapid growth, a slight increase in basal energy metabolism, and greater physical activity all tend to improve the child's appetite and increase his total food consumption. This increases his intake of protein, minerals, and vitamins, as well as energy, and permits a better physical development. Good muscle development tends to obscure slight skeletal defects.

Influence of Level of Dietary Calcium on Skeletal Development. In the 19 families whose diets were nearly adequate in calcium (averaging 10 percent deficient), about half the children (ages 1 to 20 years, inclusive) showed no signs whatever of poor skeletal development, and less than one tenth of them showed definite signs of deficiency. (See table 21.) In the 19 families whose diets were more than 60 percent deficient in calcium (averaging minus 67

Table 21

Influence of Adequacy of Dietary Calcium on Skeletal Development in Children, Ages 1 to 20 Years, Inclusive

AVERAGE ADEQUACY OF FAMILY DIETS IN CALCIUM	NUMBER OF FAMILIES	CHILDREN HAVING GOOD SKELETAL DEVELOPMENT	CHILDREN HAVING DEFINITELY POOR SKELETAL DEVELOPMENT
percent		*percent*	*percent*
-10	19	47	9
-67	19	29	16

percent), less than one third of the children were completely free from any signs of defective skeletal development, and one sixth of them showed definite signs of deficiency.

Level of Dietary Constituents and Dental Status. The average number of defective teeth per child at four age levels (1 to 5, 6 to 10, 11 to 15, and 16 to 20 years) in the children of those families whose diets were most nearly adequate in calcium and vitamins A and C was compared with that of the children in families whose diets were the most seriously deficient in those tooth-building elements. The dental status of the 1- to 5-year-old children was outstandingly better in those families whose diets were adequate (or nearly adequate) in these three essentials. (See table 22.) There was only a slight difference at the 6- to 10-year-old level; none at the higher age levels.

The vitamin D content of these family diets was not calculated. It was assumed that all these children obtained enough of this vitamin from sunshine, which is abundant the year around in Hawaii.

Errors Inherent in These Comparisons. One 4-week account of a family's food consumption is obviously not an adequate record for determining the in-

Table 22

Influence of Specific Dietary Factors on Dental Status of Children

DEGREE OF ADEQUACY OF DIETS IN CALCIUM AND VITAMINS A AND C	NUMBER OF FAMILIES	AVERAGE NUMBER OF DEFECTIVE TEETH PER CHILD AT TWO AGE LEVELS	
		1 to 5 years, inclusive	6 to 10 years, inclusive
Less than 20 percent deficient in calcium, less than 30 percent deficient in vitamin A, adequate in vitamin C	11	2.8	8.8
More than 60 percent deficient in calcium, seriously deficient in vitamins A and C	18	6.1	9.5
		4.7*	9.4*

* Average for all the families.

fluence of food on nutritional status of children. A child's nutritional status is influenced by the diet of the mother during pregnancy and lactation and by his own diet throughout infancy and childhood. However, in studies of this nature one must choose between an intensive, long-term study of a few cases and briefer studies of a larger population group. The seasonal variation in a family's diet, however, is not very great in Hawaii, as compared with diets in northern United States and other areas in the temperate zones, thus making the 1 month's sample relatively representative of the family's diet for the whole year.

In studying the diet of a family as a whole, it is necessary to make the more or less erroneous assumption that every family member eats his share of each food used by the family. On the other hand, making a record of each person's food intake at meal times will probably influence the individual's food consumption at the time to a much greater extent than does keeping a record of the total food used by the family as a whole. The latter method results in a food intake record more representative of the family's food habits in general.

RECOMMENDATIONS BASED ON THIS STUDY

A full discussion of the necessary improvements in food habits that would result in more adequate diets for these families is outside the province of this bulletin. However, certain recommendations based on the findings in this study may be made. Since the food habits of population groups change very slowly, the following recommendations are still apropos.

(1) **Foods that should be used more extensively are** milk, fruits, vegetables, whole-grain and partially refined cereal products, legumes and legume products.

Milk may be fresh, powdered, or evaporated.

Fruits should be selected to provide ample vitamin C. Local fruits, such as papaya, guava, mango, and tomato, as well as citrus fruits, are all excellent.

Vegetables should include a greater proportion of the dark-green and yellow varieties. Taro, poi, Japanese taro (dasheen), sweet potatoes, and potatoes should replace some of the calories now furnished by white rice and white bread.

Whole-grain and partially refined cereal products may be in the form of breads made with 30 to 100 percent whole-wheat or rye flours, brown (unpolished) rice or partially polished rice, rolled oats, and other whole-grain cereals used as breakfast foods or combined in various ways with other foods in prepared dishes.

Legumes and legume products provide an economical source of protein which helps to supplement the more expensive animal proteins. Tofu, with its low fiber content and good digestibility, is a good source of protein. Per unit of weight it also furnishes about as much calcium as milk.

Foods rich in vitamin B_1 (such as taro, poi, sweet potatoes, whole-grain cereals, and legumes) should be used more frequently, because most of the family diets were seriously deficient in this nutrient.

(2) **Foods that could well be decreased are** meat, fish, sweets, and expensive imported fruits and vegetables.

Meat and fish were used quite generously by most families. Some of the money spent for meat and fish should have been spent for milk, a food that provides not only animal protein but also calcium (which was found to be low in these diets), riboflavin, and other vitamins.

Sugar is best used chiefly to improve the flavor of individual foods and of some prepared dishes rather than in the form of concentrated sweets, such as candy and soft drinks.

(3) **More home food production** would help improve family diets and would also make them less expensive. A wise selection of vegetables to grow in the home garden is important. Dark-green, leafy vegetables, carrots, yellow squash, green beans, sweet potatoes, taro, and tomatoes are all much higher in nutritive value than the white or pale-green vegetables. It would be advisable for all rural families to have some fruit trees near the home, such as papaya, guava, banana, mango, breadfruit, lemon, tangerine, coconut, and avocado.

(4) **Proper supervision of children's meals and snacks** is important for the establishment of good food habits early in life. Regularity of meals should be instituted early and maintained throughout childhood and youth. Too frequent eating results in poor appetite at meal time. Candy and soft drinks dull the appetite for more important foods and are detrimental to the teeth. Between-meal snacks should consist of simple, nutritious foods and should be timed not to depress the appetite for the next regular meal.

(5) **Nutritional needs for sound dentition** should be met. The resistance of teeth to decay depends to a large extent on the diet during the tooth-forming years. The early decay of deciduous teeth in the children examined in this study indicates a need for better diets in mothers during pregnancy, the period during which these teeth are formed and calcified. Pregnant mothers should be urged to consume more milk and vegetables. Adolescent girls should be taught the importance of good diet during pregnancy and lactation, as well as throughout their own childhood.

(6) **Food habits during the preschool period** need to be improved. Too often during these years the child has irregular eating habits, is permitted to choose what he wants from the family table, and his special food needs are neglected. Adequate food and good nutrition during the years from 2 to 6 are vital in building not only a healthy body but good teeth. It is during these years (and the following 5 years) that the permanent teeth are being formed, even though they do not appear through the gums until later. The seriousness of the dental situation cannot be over-emphasized.

(7) **Nutrition education for all families** is necessary to insure adequate family diets. Most of the families in this study spent enough money for food but sometimes spent it unwisely. Boys and men, as well as girls and women, need to learn more about food values. The co-operation of the fathers must be secured if family food habits are to be improved. As long as the father in a family refuses to eat the right foods, it will be difficult to teach the children good food habits. Only continued educa-

tion, by all agencies interested in the problems of nutrition and health, can gradually give parents a full understanding and appreciation of the contribution that proper food can make to the health of the family.

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UNIVERSITY OF HAWAII
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII
